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# NA3/WP8: Astronuclear Library

ChETEC-INFRA 3<sup>rd</sup> General Assembly and Transnational Access User Meeting Debrecen, Hungary – 6-7/ June 2023

07/06/2023

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## NA3/WP8 – Overarching goals

- Development of procedures to evaluate sets of individual results (e.g. different measurements of a given nuclear cross section) to arrive to curated and community supported values: "STANDARDS" (incl. in Tasks 8.1 and 8.2)
- Creation of data libraries (T8.3) based on experimental data as raw as possible to facilitate reutilization for newer analysis – e.g. a new measurement is obtained -> reanalysis of all available data
  - 'Big Three' for Helium burning:  ${}^{12}C+\alpha$ ,  ${}^{12}C+{}^{12}C$ ,  ${}^{22}Ne+\alpha$  (T8.1)
  - Hydrogen-burning (T8.2)
  - Neutron capture for s-process (T8.3)
- Development and maintenance of the ChETEC-INFRA Webpage (T8.4): access to infrastructures, public access to all data obtained in the NAs and JRAs and other data obtained as part of ChETEC-INFRA as well as any other activities related to the project





T8.1 – A. Tumino (UKE), INFN, UMIL, CNRS, HZDR, GUF, UHULL

'Big Three' for Helium burning:  ${}^{12}C+\alpha$ ,  ${}^{12}C+{}^{12}C$ ,  ${}^{22}Ne+\alpha$ Work towards consensus on combining results from experimental techniques

D8.3: Plans for two workshops to discuss complementary studies
1) April 2022 at the Rome Global Gateway in coll. w/ IReNA
2) Catania, 1st half 2024

Continuous activity towards building consensus rates, incl. meeting at the CeNAM-IReNA Workshop on Atomic and Nuclear Quantum Effects Near Threshold @ Edinburgh (May 2023)

**D8.7**: Key publication w/description of methods and results for analysis of Big Three Agreement with EPJA (Dr. N. Alamanos) to submit manuscript there Draft of contents in preparation and soon to be circulated among those interested







T8.2 – A. Serenelli (CSIC), UMIL, HZDR, TUD

- Solar Fusion Reactions III Workshop (Berkeley, USA, July 2022) ChETEC-INFRA, NSF-N3AS network, Institute Nuclear Theory (USA) --> delayed to have it in person
- ➤ +50 participants in 9 WPs
- Post-workshop activities to obtain curated/consensus H-burning rates, preparation of article in progress to be published in Rev. Mod. Phys. (D8.6)











Example of task summarize in one plot (p+<sup>7</sup>Be)

Combination of different datasets including treatment of uncertainties (statistical, systematic)

Extrapolation (theory) to low (stellar) energies







Towards a new set of standard solar models – cross disciplinary benchmark (D8.8; ongoing)



> Sun is benchmark for stellar modeling

Solar neutrino fluxes fundamental for neutrino physics

 Solar models used as reference for particle physics
 e.g. in search for dark matter particles axions, WISPs

strong connection with other network activities, e.g. COSMIC WISPERS COST Action





T8.3 – T. Heftrich & R. Reifarth (GUF), CSIC, HZDR, TUD

https://exp-astro.de/astral/

- Extension of ASTRAL database (v0.2)
   171 isotopes as of today
- User front-end provides MACS
- Backend stores raw experimental data easiness for reevaluation when needed

(**D8.4** and future D8.9)

TUD	ASIKAL	
.02	ASTrophysical Rate and rAw data	Library
<u>Home</u>		Intern
—View Maxwellian-A	veraged Cross Section	
Isotope	Show	
(Examples: Ba138, T	'a180m, Se.)	
Download table of A Kind of reaction: all $kT \ge 30$ ke kT <= 30 ke get data	<ul> <li>STRAL MACS (1 line per isotope)</li> <li>Release version: Version 0.2 </li> <li>V (leave open for full range)</li> <li>V (leave open for full range)</li> </ul>	
-ASTRAL Releases-		
Version: Version 0.2	v	
get release info		
Antimentelle Astrophysik I C	oethe Universität Frankfurt   JAP   Datenschutz   Impressum   Kontakt	





### ASTRAL

- ~200 activation measurements from literature, including ratio to gold cross section, beam parameters, properties of n-source and target samples, geometry of the setup → MonteCarlo approach (PINO; <a href="https://exp-astro.de/pino">https://exp-astro.de/pino</a> code).
- Methods for combining different activation measurements in MACS evaluation are implemented.
- Half-lives of the target nuclides and γ-ray intensities of the activation products were also stored along with new values from the NuDat database (<u>https://www.nndc.bnl.gov/nudat3</u>). Info not yet stored as part of database.
- Available TOF measurements in the literature are being considered (measured ratio of the (n,γ) cross sections to gold or the resonance parameters are stored). Only few measurements were added to the database so far.
- Scripts and codes to reconstruct the final MACS from resonance parameters or from activation data are being developed. For other TOF data we are planning to revise the code already used in the previous work of Reifarth et al. (2018).













A test case on tungsten

Vescovi et al. in prep.





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### T8.4 – R. Reifarth (GUF), HZDR, TUD

https://www.chetec-infra.eu/

#### CHETEC-INFRA About • News • Infrastructures • Institutes Activities • Imprint

#### **ChETEC-INFRA**



Nuclear astrophysics studies the origin of the chemical elements: from the Big Bang, to stellar burning, and to neutron star mergers. ChETEC-INFRA networks the three types of infrastructures that, together, provide the capabilities needed for this quest: astronuclear laboratories supply reaction data, supercomputer facilities perform stellar structure and nucleosynthesis computations, and telescopes and mass spectrometers collect elemental and isotopic abundance data. – <u>About ChETEC-INFRA</u>.









### NA3/WP8 – ChETEC-INFRA webpage

> ChETEC-INFRA webpage – access to resources, activities, infrastructures, and more



### Resources

List of provided resources

- Solid Targets for Astrophysics Research STAR
- Development of a jet-gas target system
- Barium Star Repository
- <u>Nuclear Reaction Rates ChANUREPS</u>
- Stellar Trajectories ORChESTRA
- <u>s-process Library ASTRAL</u>
- <u>Course on Galactical Chemical Evolution Modelling</u>
- <u>Course on Stellar Nucleosynthesis Tools for HPC Clusters</u>
- <u>Multidisciplinary Guide to Astronuclear Science Cases</u>
- Translation of Stellar Yield Predictions for Comparison with the Laboratory Analysis of Meteorites
- <u>Scientific Publications</u>







### NA3/WP8 – ChETEC-INFRA webpage

### ChETEC-INFRA webpage – application for TNAs



#### **Application for Transnational Access**

The detailed eligibility and selection criteria are outlined below. The single infrastructures are described on the <u>infrastructures page</u>. Other usefull information is available about <u>Collection dates and user times</u> and <u>Templates and checklists</u>.

#### **Eligibility Criteria**

In order to be eligible, TNA proposals submitted by user groups must meet the following criteria:

- 1. The user group leader and the majority of the users must work in a country other than the country where the installation is located. The country where the installation is located is listed in the list of <u>ChETEC-INFRA TNA installations</u>.
- 2. The user group must be allowed to disseminate the results they have generated in their TNA project. If the user group is part of an SME (small or medium enterprise), this requirement can be waived.
- 3. By EU regulation, ChETEC-INFRA has to limit the provision of access to user groups with the majority of users not working in an EU or associated country to 20% of overall access. This means that proposals from outside the EU and EU-associated countries are fully eligible, until this overall limit applying to all ChETEC-INFRA supported TNA proposals has been exhausted.
- 4. If the user group leader can use national mechanisms to access ChETEC-INFRA telescopes (e.g. for some countries to access the NOT telescope), they should apply using these mechanisms and not for ChETEC-INFRA transnational access.

#### **Selection Criteria and Procedures**



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### NA3/WP8 – ChETEC-INFRA server

#### ChETEC server: 56 CPU, 128 Gb RAM, 90Tb RAID 6, IP: 142.2.212.122

### http://mc.chetec-infra.eu/ see A. Boeltzig's talk

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CHETEC-INFRA MASTERCLASS | A Journey through the Elements

#### ChETEC-INFRA Masterclass

Welcome to the home of the first ChETEC-Masterclass "A Journey through the Elements'

Join us on a journey through the elements, to discover the world of Nuclear Astrophysics. During the masterclass you will learn the basics of stellar evolution and nuclea reactions, to understand the nucleosynthesis and the formation of the chemical elements.

http://pipeline.chetec-infra.eu/ see J. Puschnig's talk



German

- English
- French
- Italian
- Czech
- Bulgarian
- Upper Sorbian



Chemical Elements as Tracers of the Evolution of the Cosmos - Infrastructures for Nuclear Astrophysics

#### Stellar Analysis Pipeline



#### http://chanureps.chetec-infra.eu/ see U. Battino's talk



#### **ChETEC AstroNUclear REPositorieS**

ChANUREPS is a platform where members of the nuclear astrophysics community provide new nuclear reaction rates to make them easily findable, open source and in a simple format Such rates could be used for many research tasks, e.g. nucleosynthesis calculations, nuclear sensitivity studies comparison when new rates are becoming available and much more

Nuclear astrophysics requires a diverse set o search infrastructure for progress. Nuclear aboratories to measur rates, and supercomputers to implement them into the computation of complex stellar models are both critically important **ChANUREPS** is









### NA3/WP8 – Summary on deliverables

- > D8.1: Web page
- D8.2: Data Management Plan
- > D8.3: Report to GA on plans for 2 workshops for Big Three
- D8.4: First release of s-process library
- D8.5: Report on expert meeting on shared data formats
- > D8.6 Paper on H-burning rates. Month 24  $\rightarrow$  delayed due to Covid delays  $\rightarrow$  draft in preparation
- > D8.7 Paper on methods and results for Big Three. Month 30
- > D8.8 Release of new generation of standard solar models. Month 30
- > D8.9 First release of sensitivity library (s-process) (joint w/WP4). Month 36
- > D8.10 Report on possible strategy for community wide sharing on raw data. Month 48



